For steam heating, 1¼-in. pipe is used almost exclusively, and the greenhouse man has found that where one line of 3½-in. pipe is required to produce a certain specified temperature with hot water as the heating medium, one line of 1¼-in. steam pipe at 0-5 lb. pressure will do the same work. This fact is inconsistent with the application of the divisors given for quantities of radiation, but the difference is probably accounted for by the fact that 1¼-in. pipe, being of so much higher temperature, is better distributed. Much of it is distributed in single lines; most of it in flat coils, and seldom in two rows, one over the other, and even then the coils are constructed so as to provide drainage, with a pitch from the supply end to the return bends at the opposite end, and back from the return

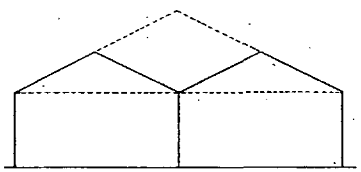

FIG. 40. SKETCH SHOWS RELATION OF CUBIC CONTENTS AND ROOF GLASS SURFACES

bends to the return header, so that the coils converge and are not close together. The pipe lines do not, therefore, interfere with each other in radiating their heat. Furthermore, with the proper boiler it is easily possible to increase the pressure as desired.

Hot-water heating was used almost exclusively 20 to 25 years ago. Now the use of hot-water heating is confined to private ranges and to small and medium-sized commercial ranges. It is practically never used in large commercial greenhouse ranges. Its cost would be prohibitive. Hot water is, of course, much more economical in small houses, but in large ranges a properly designed hot-water plant and a properly designed steam system would be equally economical, but the first cost of hot water is very much above the first cost of steam. In very large ranges vacuum steam heating is frequently used. This permits the use of smaller mains, smaller return connections and has the advantage of quick circulation, and immediately responds to sudden demands.

WARM-AIR FURNACE HEATING

GENERAL PRINCIPLES OF DESIGN

IT is assumed in the following discussion that a recirculating system is to be installed, with a maximum air temperature at the registers ranging between 175 and 185 deg. fahr., maintaining 70 deg. inside in the coldest weather.

Under the conditions just indicated the procedure to be followed in designing a gravity warm-air furnace heating system may be summarized as follows:

1. Determine the hourly heat loss H, from each room in British thermal units when the room temperature is 70 deg. fahr., and the outside temperature is 10 deg. above the lowest on record. Include any cold floors, ceilings, and partitions in the computations, and assume unheated spaces are at 30 to 35 deg. fahr. For heat transmission factors see any standard text on heating and ventilation, as this part of the work is exactly the same as for a steam or water heating system.

2. Determine the size in square inches of the leader (basement pipe), to each room by dividing the heat loss from each room (obtained in (1) above), by the heat carrying capacity of 1 sq. in. of leader pipe for first, second or third floor runs as the case may be. Leader pipe capacities over a wide range of register temperatures, for a three-story installation, are shown in Fig. 41, and a typical example is presented in the following pages. No leader should be less than 8 in. in diameter, nor over 12 ft. in length. If leaders must be extended beyond 12 ft., or have to be run with angles of more than 45 deg., then the diameter should be increased one pipe size.

3. The wall stacks are made as near the leader size as possible, but may be reduced to 75 per cent of the area of the leaders with little effect on their capacity.

4. Registers for the warm air inlets should have a free area exclusive of all grille work not less than the area of the basement leader pipe.

5. The recirculating duct should be made at least equal in area to the sum of the areas of the warm air leaders and should be run with as few angles, bends, or offsets as possible. The effect of properly and improperly designed recirculating ducts on furnace capacity is discussed in a following section. This duct should enter the furnace through a shoe of full area, the top of which is not above the level of the grate (See Fig. 43).

6. The recirculating register should be placed preferably in the first floor hallway and the air should have free access to it on all sides. Registers in corners or against a wall are at a great disadvantage. The free area through the register should at least be equal to the area of the recirculating duct.

7. The furnace should be selected on the basis of grate area, and at the same time the free area through the furnace must be not less than the sum of all leader areas. It is evident that the coal burned on the grate must furnish all the heat required to keep the house at 70 deg. in coldest weather, and at the same time provide for any line losses between the furnace and the rooms, as well as radiation losses from the furnace, and the heat carried away in the smoke gases. Since the total heat loss H from the house has been determined in (1), it is first necessary to allow a reasonable factor for line losses which can be taken at 25 per cent of H. The heat lost from the furnace and in the smoke gases is approximately 40 per cent of the heat in the coal, which leaves 60 per cent for

Material for this section was prepared especially for THE GUIDE 1923 by Arthur C. Willard, Urbana, Ill.